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Employability Skills: Perspectives from a Knowledge-Intensive Industry.

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Employability Skills: Perspectives from a Knowledge Intensive Industry.

ABSTRACT

Purpose: While the global education debate remains focused on graduate skills and employability, the absence of a shared language between student, academic and industry stakeholder groups means that defining industry skills requirements is both essential and difficult. The aim of this study was to assess graduate skills requirements in a knowledge intensive industry from a demand perspective as distinct from a curriculum (supply) viewpoint.

Design/methodology/approach: Skills items were derived from a breadth of disciplines across academic, policy and industry literature. CEOs and senior managers in the innovation and commercialisation industry were surveyed regarding perceptions of skills in graduates and skills in demand by the firm. Two rounds of exploratory factor analyses were undertaken to examine employers' perceptions of the skills gap.

Findings: First order analysis resolved 10 broad constructs that represent cognitive, interpersonal and intrapersonal skills domains as applied in this industry. Knowledge, leadership and interprofessional collaboration feature as prominent skills. Second order analysis revealed employers' perceptions of graduate skills specifically centre on organisational fit and organisational success. An over-arching theme relates to performance of the individual in organisations.

Research limitations/implications:

Our findings suggest that the discourse on employability and the design of curriculum need to shift from instilling lists of skills towards enabling graduates to perform in a diversity of workplace contexts and expectations centred on organisational purpose.

Originality/value: In contrast to the heterogeneous nature of industry surveys, we targeted a homogenous sector that is representative of knowledge intensive industries. This study contributes to the broader stakeholder dialogue of the value and application of graduate skills in this and other industry sectors.

INTRODUCTION

The higher education sector plays a leading role in the transition to knowledge-based economies through the supply of technological innovation and skilled human capital (e.g., NCIHE, 1997; EC, 2003; NA, 2007). However, concerns have long been voiced about the suitability of graduates for employment, the applicability of their skills to a changing economic landscape and the subsequent impact on productivity that arises from an employability skills gap (SCANS, 1991; Packer, 1993; NCIHE, 1997; DETYA, 1998; EC, 2003; Leitch, 2006). The debate over graduate skills and employability remains one of the core elements of a wider education debate that encompasses the compounding influences of the globalisation of education (Adelman, 2009), evolving workplace requirements and industry demographics wrought by new technologies (Levy, 2010; Frey and Osborne, 2013), increased competition from rising eastern mega-economies (EC, 2003; NA, 2007) and the current climate of global financial instability (NA, 2010). In the current economic climate, employer demands centre on an expanded skills set, including the application of interpersonal and intrapersonal behaviours, to underpin the systemic innovation required for even medium-term business competitiveness (Stasz, 2001; Harvey, 2003; Casner-Lotto and Barrington, 2006; Moreland, 2007; Finch *et al.*, 2013; SA, 2011; NA, 2010; CBI, 2011; Whitefoot and Olson, 2012).

Commentators have placed the blame for an employability skills gap at the feet of different stakeholders. At the national level, Richens (1999) notes that the structure of education makes it difficult to implement systematic change even when collaborative processes exist between industry and education. At the university level, higher education institutions have failed to impart the necessary business and soft skills for graduate employment in economies that are increasing complex and competitive (Harvey, 2001; Stasz, 2001). At the level of the curriculum, academics are uncomfortable teaching skills beyond their discipline-specific experience (Barrie *et al.*, 2009; De la Harpe *et al.*, 2009). On the flip side, it has been claimed that employers have not communicated their skills requirements clearly to the higher education sector (Rosenberg *et al.*, 2012) and that industry has its own responsibility to train graduates for each sector (Holmes, 2001; Harvey, 2001, 2005).

Recent reports also note the lack of empirical data regarding the relationship between skills and employment (Mason *et al.*, 2009; Pellegrino and Hilton, 2012; Rosenberg *et al.*, 2012;

Mourshed *et al.*, 2012; Heimler *et al.*, 2012). Graduates are employed in non-routine work environments. Thus employment and career trajectories are simply not a matter of matching skills required and skills possessed (Holmes, 2001; Harvey, 2005; Hinchliffe and Jolly, 2011). Holmes (2001) paints the transition into the workplace from recent graduate to worthy employee as a process of developing a shared language between employee and employer around the value and application of skills in the specific industry.

Pellegrino and Hilton (2012) draw attention to the lack of a shared meaning across and between stakeholder groups (academics, industry and students) in their understanding of skills. In turn, the lack of a shared meaning has exacerbated the lack of engagement amongst these groups (Harvey, 2005; Pellegrino and Hilton, 2012) to the extent that it has been claimed: “employers, education providers and youth live in parallel universes” (Mourshed *et al.*, 2012). The biggest challenge requiring resolution relates to the different meanings used by each stakeholder group to describe skills and their application (Pellegrino and Hilton, 2012). Understanding how skills are described and applied in industry is an important step in deriving shared meanings between stakeholders.

To understand the evolving industry demands around graduate skills required in an increasingly knowledge-intensive industry environment we have sought to assess industry expectations and experiences of graduates working in industry organisations at the front of the technology innovation curve. Specifically, our study examines perceptions of the employability skills gap through the eyes of the CEOs and senior managers of the Australian innovation and commercialisation sector. We breakdown and contextualise broad skills descriptions into component elements relevant to the sector and apply a quantitative and inductive exploratory analysis of the perceived gap between employers’ demands and what they see in newly hired graduates. Our survey explores skills in use at the organisational interface of the individual, the team and the firm in a knowledge-intensive industry focused on bringing innovation to the marketplace. Such insights add to the greater skills debate by assessing skills requirements that will filter through to other industry sectors over time. Such insights are also essential to the design of education programs in the higher education sector that address employer demands.

BACKGROUND TO THE CURRENT GENERIC SKILLS FRAMEWORKS

This section does not intend to provide a comprehensive survey of the broader employability skills debate of the last twenty years but rather profiles current frameworks and some parameters of the debate relevant to this paper.

The SCANS (1991) report in the US laid the groundwork for current frameworks when it defined three foundational skills (basic skills, thinking skills, personal qualities) underpinning five competencies (use of resources, interpersonal skills, information, systems and technology) needed for solid job performance. Lord Dearing echoed these same requirements in a substantial report that changed the landscape of higher education in the United Kingdom (NCIHE, 1997). From early skills frameworks that focused primarily on technical knowledge and skills, critical thinking and communication, the SCANS and NCIHE reports initiated a global shift towards including skills in knowledge management, information literacy, teamwork, career management and citizenship as essential for graduate employability.

The current skills debate focuses upon teaching and learning a broadly defined set of cognitive and affective capabilities labeled as 21st Century Skills considered to underpin career success in knowledge economies. Table 1 provides the range of perspectives among skills frameworks aligned according to the dimensions advocated by Pellegrino and Hilton (2012) (see below). The examples highlight the diversity of approaches and commonalities between frameworks. The global Assessment and Teaching of 21st Century Skills [AT21CS] project defined four domains of skills: ways of thinking, ways of working, tools for working and living in the world (Binkley *et al.*, 2010). In Europe, the Organisation for Economic Cooperation and Development [OECD] Definition and Selection of Skills Programme describes three clusters of key competencies (acting autonomously, interact in heterogeneous groups and using tools interactively) that can be mobilised to meet social and economic demands and individual goals related to 21st Century work and living (OECD, 2005). In this context, the term competency refers to the application of knowledge and skills to meet complex demands. Building on the Conference Board of Canada (CBC, 2000) framework, the United Kingdom Commission for Employment and Skills (UKCES) derived a framework that emphasises on the work-readiness of graduates (UKCES, 2009). Focusing on the K-12 education sector, the Partnership for 21st Century Skills [P21CS] emphasizes mastery of core subjects and interdisciplinary themes as underpinning learning and innovation skills, information, media and technology skills, and life and career skills (P21CS, 2009).

***** INSERT TABLE 1 HERE *****

The relationship between HE institutes and the labour market is context specific at the national level (Tomlinson, 2012). Thus, national governments and their agencies have developed and adopted a variety of initiatives, approaches and policy instruments that encompass skills development (de Weert, 2011; Kottmann and de Weert, 2013) including the benchmarking of student learning outcomes (OECD, 1999, 2011; Jerald, 2008). For example, the high level discourse (e.g., NCIHE, 1997; DES, 2003; Leitch, 2006; UKCES, 2009) informed interventionist UK government policy by successive governments that facilitated deregulation of the education market, greater dissemination of information regarding career choices (www.nationalcareersservice.direct.gov.uk) and increased HE-industry collaboration to address labour market demands (DBIS, 2011, 2013). Collaborative efforts in skills training encompass significant funding of projects aimed at university-industry partnerships (Tallantyre and Kettle, 2011) and programmes directed towards work placements and employer ownership of skills training pre- and post-graduation (UKCES, 2010, 2013, 2014).

In the USA, where curriculum content is state-controlled, the Common Core State Standards Initiative (www.corestandards.org) has redesigned the English and Maths curriculum to embody a broader view of knowledge and skills requisite for work and life (NRC, 2014). In Australia, government policy has focused on the vocational education and training sector through the development of performance definitions around core skills (DEEWR, 2008) and workforce planning (SA, 2011; AWP, 2014) to support future skills demands of the manufacturing industry. In contrast to the UK, the notion of funding work placements for Australian university students has largely met with government and industry inaction due to high cost and resource intensity (Lomax-Smith *et al.*, 2011; AWP, 2014).

Following formulation of skills frameworks came the realisation that the assessment of soft skills and deeper learning outcomes are poorly developed or non-existent in curriculum (Koenig, 2011; Pellegrino and Hilton, 2012). This saw ensuing developments also follow a tangential pathway in the development of protocols for skills measurement (Binkley *et al.*, 2010; OECD, 2011; Koenig, 2011; Blades *et al.*, 2012; Kyllonen, 2012) and teacher education (Soland *et al.*, 2013; NRC, 2014). Such efforts have been at the expense of developing more robust second and third generation frameworks based on empirical research (Pellegrino and Hilton, 2012; Lai and Viering, 2012).

Pellegrino and Hilton (2012) examined lists of 21st Century skills and found commonalities they proposed fitted three over-arching domains of cognitive, interpersonal and intrapersonal competencies (Table 1). These authors acknowledge foremost the skills in each domain support, enhance or impinge upon skills in the other domains and the complex relationships of skills remain to be fully elucidated. Lai and Viering (2012) also note that few recognised skills have a “relatively robust and established research basis within education and psychology”. Pellegrino and Hilton (2012) propose the tripartite framework serves as a starting point for research that further defines each construct and its relationship to other skills constructs. Such research is paramount in defining the relationship between skills and employment.

As the debate evolves, new skills are being proposed as important in the 21st Century, such as: action orientation, leadership, executive function, social influence, assertive communication and service orientation (Pellegrino and Hilton, 2012, and references therein). An important element is the lack of enterprising (or entrepreneurial) skills in graduates to support business agility (Gibb, 2002; Moreland, 2007; SA, 2011; NIH, 2012; Whitefoot and Olson, 2012). An entrepreneurial mindset, especially in graduates of the science-based and technical disciplines, is advocated in order to build foundational platforms for knowledge-based economies (EC, 2003; NA, 2007, 2010; NIH, 2012). Such calls are recognition that skills underlying entrepreneurial activity are important for career success of the individual (Gibb, 2002; NIH, 2012; Whitefoot and Olson, 2012) as well as business growth through innovation that is both systemic and sustainable (Christensen, 1997; SA, 2011).

It is important to note that skills frameworks often reflect the perceptions of the group, industry, academic or government consultancy, developing the framework. While commonalities are evident, some important differences that impact on education and training for knowledge intensive industries remain to be resolved. Table 1 serves to highlight the contrasting viewpoints of the role and value of skills as displayed in published skills frameworks. The varying importance placed upon the body of discipline-specific knowledge a graduate should know represents an interesting case in point, especially when you consider such knowledge represents the cornerstone of university graduate capability statements.

The OECD (2005), UKCES (2009) and AT21CS (Binkley *et al.*, 2010) emphasise broadly based *functional* knowledge and skills relevant to personal, social and economic wellbeing rather than an in-depth subject knowledge that may never be applied once graduated. In these frameworks, knowledge as recall of discipline facts (Bloom, 1956; Anderson and Krathwohl, 2001) has transitioned to the gathering and processing of knowledge such that the essence of 21st Century skills is “what students can do with knowledge rather than what units of knowledge they have” (Silva, 2008). The outcome of this perspective has *knowledge*, as a construct, described somewhat narrowly as information literacy (defined as evidence-based research and bias recognition) and literacy in information and communications technology [ICT] (Ananiadou and Claro, 2009; Pellegrino and Hilton, 2012).

Other frameworks, however, feature the importance of discipline-specific knowledge. The P21 skills framework emphasises a “focus on mastery of core knowledge and understanding academic content at higher levels” (P21CS, 2009). Indeed, empirical research shows critical thinking, a fundamental cognitive skill and essential graduate attribute, is a domain specific construct that evolves as the person acquires discipline-based knowledge (Kuncel, 2011; Lai and Viering, 2012).

Employer surveys are also equivocal about the role of discipline-specific knowledge. Technical skills rank 11th in the NACE (2013) survey; while another survey has mathematics and science ranked 15th and 16th, respectively, out of 20 skills (Casner-Lotto and Barrington, 2006). Harvey and Mason (1996) report 38% of employers consider knowledge of little or no importance, and suggest a short shelf life as the cause. Other surveys reported, however, that employers favoured both a broad range of widely applicable skills and knowledge, and in depth technical skills and knowledge in one or more disciplines (Saflund, 2007; HRA, 2010). Within the skills mix, Saflund (2007) and Rosenberg *et al.* (2012) report employer comments that it is easier to remedy a lack of technical knowledge than a deficiency in soft skills. Pointing to a partial solution, the NACE (2013) survey notes that employers impose a threshold GPA when hiring graduates, this implies a performance criterion for discipline knowledge despite a low ranking of technical skills. Thus, “employers view 21st Century skills as an addition to core (discipline) knowledge” (Houston cited in Hilton, 2010) and, implicitly, graduates’ technical knowledge is assumed (Saflund, 2007).

Leadership is a skill rated as very important by industry and, yet, it has not featured in skills frameworks. Pellegrino and Hilton (2012) describe leadership as an interpersonal skill encompassing leadership, responsibility, assertive communication, self-presentation and social influence with others. On the other hand, Casner-Lotto and Barrington (2006) provide industry-centric terms to describe the concept of leadership as an applied skill that “leverages the strengths of others to achieve common goals” and as the use of “interpersonal skills to coach and develop others”. Leadership ranked 10th (out of 20 skills) with ~82% of industry regarding the skill as ‘very important’ in new workforce entrants (Casner-Lotto and Barrington, 2006). Moreover, NACE (2013) ranked leadership as 2nd on a list of desired attributes and reports 76% of industry seek evidence of leadership skills on graduates’ résumés. Millennial Branding (2012) reports that 50% of companies are looking for leadership skills in new graduates. Any perceived leadership deficit in graduates arises from their lack of familiarity with business and corporate cultures (Casner-Lotto and Barrington, 2006). A McKinsey meta-survey of US industry reports that employers are already finding management positions difficult to fill (Manyika *et al.*, 2011), a sentiment also expressed in an Australian survey (AIM, 2009). With a generational shift brought on by retirement of the baby boomer generation, the impact of a leadership skills deficit on organisations will become more overt over time.

While the diversity of stakeholders input into the employability skills debate is healthy, the broad base of discourse has contributed to a lack of shared meaning across and within stakeholder groups. In turn, the lack of a shared meaning has exacerbated the lack of engagement amongst these groups (Harvey, 2005; Pellegrino and Hilton, 2012). The biggest challenge requiring resolution relates to the different meanings used by each stakeholder group to describe skills and their application (Pellegrino and Hilton, 2012). Understanding how skills are described and applied in industry is the first step in deriving shared meanings between stakeholders.

BACKGROUND TO THE INNOVATION AND COMMERCIALISATION INDUSTRY

Focused on bringing complex emergent technology to the marketplace, the innovation and commercialisation sector is a high profile industry sector with significant influence on future health of national economies (Christensen, 1997; Wright *et al.*, 2007; Meyer *et al.*, 2011). A conceptual framework displaying the types of organisations in the innovation and

commercialisation infrastructure is presented in Figure 1. The figure provides an overview of the value chain and the diversity of contributors to that chain, ranging from research to sales and marketing, and includes funding agencies, lawyers and business development specialists. The diversity of contributors underscores the networked nature of the innovation and commercialisation infrastructure. The sector is highly dependent on technical knowledge and skills. Success in the industry is dependent not just on the inherent novelty and utility of the innovation but on the ability to sell the innovation in a market populated with competing technologies or services. The sector demands highly qualified graduates replete with technical mastery (defined as *success in research* (MacKinnon *et al.*, 2010)) and imbued with a suite of entrepreneurial and generic skills focused on a commercial imperative (Murray and Hsi, 2007a,b, cited in Hilton, 2008). Furthermore, no one person may manage the pipeline from start to finish and thus players in the industry must also have an appreciation of their role in the process as well as the roles and approaches of other contributing disciplines. To a large degree, the human capital needs of the sector can be considered at the forefront of emerging skills requirements of knowledge-based industries (Wright *et al.*, 2007; Phan *et al.*, 2009; Austin *et al.*, 2009).

RESEARCH DESIGN AND METHODOLOGY

The names of target Australian organisations, the appropriate personnel and their contact details, were collected through internet searches of government and private directories of research, development and commercialisation organisations and through search terms such as ‘technology transfer’, ‘research commercialisation’, ‘technology commercialisation’, ‘intellectual property’ and variations thereof. The organisations targeted are knowledge-intensive innovation industries and the adjuncts to these industries, and thus may not be representative of the commercialisation pipeline but rather representative of the innovation and commercialisation pipeline (Figure 1; Table 2). As the industry in Australia is small, the survey was undertaken by telephone interview to improve response rates.

***** INSERT FIGURE 1 HERE *****

***** INSERT TABLE 2 HERE *****

A list of skills was drawn from a broad sweep across disciplines and reports from academic, industry, government and policy areas. Sources of skills lists encompassed generic and

specific competences of multiple disciplines within the European Union Tuning Project (www.unideusto.org/tuningeu/competences) including the social sciences (business, nursing and history) and natural sciences (physics, chemistry, earth sciences); skills and competencies from government and think-tank reports (such as DETYA, 1998; DEST, 2002, 2007); academic literature including that covering entrepreneurship (such as Gartner and Vesper, 1994; Gibb, 2002; McLeish, 2002); and the graduate capabilities lists of a number of Australian universities, were also partitioned into individual skill traits. Skills were analysed through identification of overlapping items and core themes from the published lists. Our final list of skills was not meant to be exhaustive given the rapid evolution of the generic skills debate, however the aim was to provide broad coverage of the skills present in published lists.

Leveraging the extensive experience of the two researchers, each skill was analysed for contextual relevance within the knowledge hierarchy of the innovation and commercialisation industry and across the broad representation of the value chain (Figure 1). For instance, information literacy is regarded as a core skill, but what does this mean? Definitions in the literature provide that information literacy is the collection of information from a diverse array of sources, often using modern technologies (Pellegrino and Hilton, 2012). In the context of (modern) knowledge-intensive industries, information has value, so it is not just the collection of information that is important, but also how information is evaluated, assimilated, shared, and new knowledge created and leveraged within the firm. In this particular industry, where innovation leads to a new product and intellectual property protection is an important aspect of the business function, the documentation of the information source and accurate reporting of information are also key elements of the innovation process.

As outlined in the previous paragraph, final skills items were derived based on manifestation of, or requirement for, each specific skill in the innovation and commercialisation context and considered as germane to the industry (Table 4). In contrast to most industry surveys, the research design we chose used a larger number of skills items and applications (>50) rather than a small number of skills items (<15) to avoid the compounding issues arising from assuming a shared language that describes the skill and infers its application in industry (see above). This also provided a much more nuanced data set.

Through the survey we aimed to evaluate the gap between the skills perceived as required by industry and those perceived as evident in graduates entering the industry. Thus, each of the 61 skills items included two questions:

- How important (IMP) is the skill to your organisation?
- How evident (EVD) is the skill in the graduates you employ?

The questionnaire design included a Likert 5-point scale with no neutral point to avoid courtesy bias on the part of respondents and eliminate ambivalence. The survey also included questions that addressed the demographics of respondents' organisation, and the credentials of the respondent and recently employed personnel.

From the viewpoint of the respondent, the relative importance of any one skill in business activity is evaluated in comparison to a suite of other skills. The respondent is explicitly aware of this process of the survey and ranks the skills accordingly. In reviewing skills evident in the graduate, however, the respondent is not engaged in a comparative ranking; the person is explicitly providing a value judgement about a perceived distance measure (deficiency) that implicitly provides an independent measure of the importance of the skill in the respondent's activities. For this reason, it is the distance between the means of IMP and EVD that provides meaningful measures of skills importance (i.e., $IMP_{mean} - EVD_{mean}$ as a variable in itself), and it is the test of this distance that is the focus of this study. In using the subtractive difference between the measures of perceived importance and evidence, we have sought to operationalise issues of concern around the employability skills gap in this sector.

The analysis of responses utilised SPSS v21. An analytical iterative progression was followed with data transformation and interpretation as follows: (1) one-tailed t-tests of significance, with Bonferroni correction to allow for inflated familywise Type I error rate (for 61 items, $\alpha = 0.00082$; Field, 2013), on the difference between the means of IMP and EVD (testing $\mu_{IMP} > \mu_{EVD}$), (2) tests of size effect using Cohen's d test, and (3) classification of the $IMP_{mean} - EVD_{mean}$ items into constructs (skill fields) using first order and second order exploratory factor analysis (EFA). Kaiser-Meyer-Olkin (KMO) tests and Bartlett's Test of Sphericity were used to evaluate the linear association of items in correlation matrices. Constructs were extracted using principal component analysis (PCA) with Promax rotation, to allow for correlation between variables, and Kaiser normalisation (Field, 2013). Internal consistency of construct validity was examined using Cronbach's α coefficient (Reinard, 2006; Field, 2013).

RESULTS

Respondent Characteristics

The survey realised 207 responses from industry personnel at a response rate of 45% with 94.2% of respondents representing senior-level management: middle (25.1%) and upper level (senior manager: 36.7%; CEO 32.4%). Four sectors dominated the industry groups making up 88% of the respondents: health and community services (20%), property and business services (20%), agriculture, forestry and fishing (22%) and a miscellaneous group (various) (26%). Mining, manufacturing, government administration and defence, utilities and communication services were all at or below 4%. The majority (70%) of industry organisations were under 40 years of age with 55% less than 20 years old and over half of the organisations employed up to 100 employees and all had less than 2000 employees. As one would expect, the geographic focus of the organisations was predominantly international (49.8%) or national (39.6%) with few having a regional (8.2%) or local (2.4%) focus.

The survey respondents represent a highly credentialed population of individuals: 42% had a highest qualification of a PhD, 23.5% had a master's degree and 34% graduated with a bachelor's degree (including Honours). Of the employees hired by the organisations in the last three years, the majority (83.8%) of employees were recent graduates (37.3%) or had graduated less than a year beforehand (14.1%) or were previously employed graduates (32.4%). Non-graduates accounted for only 16.2% of recent employees. A large percentage of graduates employed had the higher-level qualifications of master's degree (12.9) or PhD (31.6) and 42% had a bachelor's degree. The high proportion of graduates with post-bachelor's degrees (44.5%) supports the notion of an industry requirement for an advanced knowledge and skills base.

An Employability Skills Gap

At the simplest level, the survey sought to test the employers' perceptions of a skills gap between the skills in demand (i.e., IMP) in the innovation and commercialisation sector and the skills level evident in graduate employees. The average $IMP_{mean} = 3.6$ compared with the average $EVD_{mean} = 2.78$. For each of the 61 items, the IMP_{mean} response was significantly higher than the EVD_{mean} (Table 3; $p/2 < 0.001$; one tailed t-test with Bonferroni correction). Cohen's d effect sizes of medium or larger (>0.5) were obtained for 59 items with small to medium (0.320 and 0.456) effect sizes achieved for two items. This suggests a significant and

meaningful gap is perceived between the skills considered essential for industry activity/success and those evident in recent graduates.

***** INSERT TABLE 3 HERE *****

Derivation of Skills Constructs and Description

The KMO statistic (0.924) indicates the sample size is sufficient for the number of items in our scale while the Bartlett's test ($\chi^2 = 8347$, $df = 1830$, $p < 0.001$) indicates the correlation matrix is not an identity matrix (Field, 2013). Together these two tests indicate our correlation matrix is suitable for factor analysis. Ten constructs, each with Eigenvalues of > 1 , were extracted using first order EFA based on $IMP_{mean} - EVD_{mean}$ for the 61 items that together explained 63.5% of the variance (Table 3). Cronbach α values exceed 0.7 for all factors, including factors with nine, 10 and 15 variables (at 0.880, 0.905 and 0.911, respectively), indicating a high level of internal reliability in the factor outcomes.

Table 3 shows alignment of skills items in each of the 10 extracted constructs and describes the labels applied to constructs:

- *Knowledge/Learning* construct projects an outcomes focus relating to the process of individual learning and also the leverage of information and knowledge in an organisational sense in ways that contribute to intellectual capital and add value to companies. An understanding of the technical discipline and the two way communication with specialists is paramount to both understanding the needs of the company and accurately imparting knowledge regarding external developments. Such activities are important in knowledge intensive industries for maintaining sustainable competitive advantage (Wang and Noe, 2010).
- *Enterprise Leadership* recognises a coalescence of higher order actions, attitudes and personalities that are necessary to progress new ventures (Bass and Bass, 2008). In an organisational sense, knowledge of administrative systems would play an important role in achieving positive outcomes.
- *Business Function* relates to systems thinking and comprises a core of business knowledge relating to elemental functioning of any business entity.
- *Technical Management* recognises that careers in this industry build on a foundation of discipline knowledge and technical mastery to include higher order skills application and leadership in a project context that is client focused.

- *Team Worker* recognises a suite of inward-focusing skills that are important individual pre-requisites that contribute to the effective performance of a team.
- *Interprofessional Collaboration* is outwards-focused and recognises a suite of skills that coalesce around active collaboration and communication with other professionals in interdisciplinary team environments. This construct recognises the need for the firm to interact through complex relationships involving multiple entities in the value chain (Figure 1).
- *Leadership Antecedence* comprises skills considered enterprising in nature and that contribute to the performance dynamics of both the individual and, through communication, the firm (Gibb, 2002).
- *Improve* comprises skills relating to lifelong learning. The construct contains only two items, but nonetheless, was not discarded as the Eigenvalue was above 1, the items are well defined and the constituent items intuitively cluster.
- *Progress* comprises a suite of skills that recognises the process of picking a potentially winning technology and progressing the technology through to a product (i.e., innovation transformation) (Wright *et al.*, 2007, and references therein).
- *Create* reflects a focused practice of the individual to create new knowledge. The sharing of new knowledge, however, aligns in the construct *Knowledge/Learning*, which may underscore the importance of knowledge management within the firm. Our constructs distinguish between knowledge gathering, filtering and leverage within the firm (*Knowledge/Learning*) versus building new knowledge (*Create*) and thus reflect the classic cognitive categories of Evaluation (or Evaluating) and Synthesis (or Creating), respectively, as defined by Bloom (1956) and Anderson and Krathwohl (2001).

Derivation and Description of Metaconstructs

To examine relationships between the construct fields, a second round of EFA was undertaken using the 10 constructs as variables. The KMO statistic (0.917) and Bartlett's test ($\chi^2 = 1201$, $df = 45$, $p < 0.001$) indicate the matrix is factorable. Principal component analysis realised two metaconstructs with Eigenvalues > 1 that explain 68% of the total variance (Table 4). While 21st Century skills frameworks recognise three clusters of skills: cognitive, interpersonal and intrapersonal (Pellegrino and Hilton, 2012), such distinctions appear not to be recognised in these end-user demand responses. Rather, the two metaconstructs

essentially prescribe domains of function of the individual in an organisational context in this specific industry sector.

***** INSERT TABLE 4 HERE *****

Organisational Fit comprises skills constructs that represent a (basal) scope and level of knowledge and skills required of employees to work in the current and ever changing business structures and strategies of innovation and commercialisation organisations. When considered as a whole, the skills fields that resolve in this metaconstruct describe the individual's fit into an organisation's structure, strategy and culture. On the other hand, the metaconstruct *Organisational Success* describes higher order skills associated with a successful career in the sector, reflecting respondent perceptions, and inevitably some respondent bias. The latter metaconstruct is based on experiential learning, building upon, rather than derived from, explicit instruction. Graduates enter the industry sector as technical experts and usually learn their basic business and management skills as they rise through the ranks of the organisation as well as gain the experiential knowledge needed to progress new technologies into products (Pisano, 1994).

DISCUSSION AND CONCLUSIONS

The Employability Skills Gap

A perception of a deficiency in graduate skills implies that industry considers it can do better, and may be being held back by graduates in its pursuit of productivity (Packer, 1993). Conversely, perceptions that graduate skills exceed requirements means that industry do not utilise the skills of their employees and this represents an unused capacity within the organisation. In surveying industry with an extended list of skills we looked to assess whether graduates possessed individual elements around a broad skill description (e.g., teamwork, problem-solving) that met industry expectations. In this knowledge intensive industry sector, the perceptions of the importance of all 61 skills items (as defined by IMP_{mean}) is significantly higher ($P < 0.001$) than perceived as evident (EVD_{mean}) in graduates. Our results empirically confirm the concerns regarding the deficiency in skills between graduate exit and employer requirements that have been voiced over the last 20 years in policy debate and descriptive surveys of the US (e.g., SCANS 1991; Casner-Lotto and Barrington, 2006; Saflund, 2007; NACE, 2013), UK (Harvey and Mason, 1996; NCIHE, 1997;

Harvey, 2003; CBI 2011) and Australian (DETYA, 1998; DEST, 2002, 2007; AIM, 2009; SA, 2011) workforce contexts. Beyond this, our analysis has categorised the skills so that they can be better understood for the purpose of change and redesign of curriculum in the higher education sector.

Skills from a Demand Perspective

Rather than ascribe importance to items in a list of skills, we focused on the difference between skills importance to the organisation and skills evident in graduates as *perceived* by the employer as a measure of the employability skills gap. As a scale development technique, this approach mirrors implementation of the consumer-based Expectation-Confirmation Model (Poister and Clayton Thomas, 2011) and the use of SERVQUAL in researching service quality (Ladhari, 2009). In our scale we are not considering the individual graduate but rather the experiential perception of what graduates as a cohort bring to the organisation and what skills are important to each organisation. Thus, our results reflect an interpretation of skills by a highly credentialed and successful business cohort in an industry that leverages knowledge and innovation for commercial outcomes and lies at the forefront of innovation and technology management. By populating the survey with an extended list of skills contextualised for the industry, we have sought to overcome the limitations of an assumed language (Mourshed *et al.*, 2012; Pellegrino and Hilton, 2012). Our study does not pre-empt the complex relationships between skills (Pellegrino and Hilton, 2012; Lai and Viering, 2012) but seeks to draw relationships around interpretation through exploratory factor analysis.

Of the ten skills constructs derived from first order EFA, eight map to the three broad clusters recognised by Pellegrino and Hilton (2012): cognitive competencies (*Knowledge/Learning, Create, Business Function, Technical Management, Progress*), interpersonal competencies (*Interprofessionalism*) and intrapersonal competencies (*Team Worker, Improve*) (Table 1). In contrast, two constructs contain elements that span competency domains. *Leadership Antecedence* features both interpersonal and intrapersonal skills and recognises that careers in this sector require high motivational drivers and well-developed communication skills. *Enterprise Leadership* contains elements that span all three domains of competency and recognises that successful new ventures are at the heart of this industry sector. Both constructs feature traits considered entrepreneurial or enterprising (Gartner and Vesper, 1994; Lumpkin and Dess, 1996; Gibb, 2002). Although the sector is considered highly entrepreneurial, 'entrepreneurship' as a construct was not resolved. These outcomes may

reflect a pervasiveness of enterprising behaviours across the sector rather than entrepreneurship *per se* - being entrepreneurial is a lesser requirement than being an entrepreneur (Gibb, 2002).

Our exploratory factor analysis also provides for further discussion of three elements of the employability skills debate around knowledge, teamwork/collaboration and leadership. Furthermore, and not surprisingly from an industry viewpoint, our skills constructs and metaconstructs infer an emphasis on outcomes and performance rather than present a process oriented view characteristic of curriculum.

The Role and Value of Knowledge

Knowledge as defined in the narrow sense as information literacy and ICT literacy (Silva, 2008; Pellegrino and Hilton, 2012) or in the broad functional sense within the context of everyday tasks (OECD, 2005; Binkley *et al.*, 2010) seems inadequate when we consider our constructs. In contrast to the equivocal role of content knowledge that features in the employability skills discourse, discipline-specific knowledge derived from explicit training features in two of our constructs: *Knowledge* and *Technical Management*. Technical knowledge serves as both a prerequisite for individual and firm-centred learning in the cognitive process of information evaluation, synthesis and dissemination as well as the application of critical thinking skills (*Knowledge*). Building upon the base of discipline knowledge and technical mastery, successful careers in this industry include higher order skills of leadership and management that are derived experientially (*Technical Management*). Leaders in the sector are usually highly credentialed and the industry focus is on the application of, and value-adding to, deep knowledge of a technical discipline towards developing a viable commercial product for the marketplace. Such an outcome supports the notion that disciplinary knowledge is both valued by industry and assumed for graduates (Saflund, 2007; Hilton 2010).

On the other hand, the importance of experiential knowledge in the innovation and commercialisation sector is acknowledged by resolution of two constructs: *Business Function* and *Progress*. *Business Function* covers requisite knowledge for understanding and effecting commercial operations. *Progress* relates, at first glance, to knowledge requisite for career success in the specific industry sector surveyed, however it can be argued that the skills construct applies to any knowledge-intensive sector seeking sustainability through systemic

innovation (Christensen, 1997; Wright *et al.*, 2007). It is also not surprising that *Business Function* and *Progress* resolve in the metaconstruct *Organisational Success* in this sector. At a senior management level, organisational transformation and viability is dependent on business systems thinking and the experiential learning derived from plotting commercialisation pathways for complex technological innovation (Pisano, 1994).

Teamwork versus Interprofessional Collaboration

Our constructs highlight a distinction between the traditional descriptions of teamwork versus collaboration. Teamwork is a topic central to skills frameworks and descriptions often include 'ability to work in groups', 'working together for collaborative learning' and 'division of labour' (Lai and Viering, 2012, and references therein). The elements coalescing in the construct *Team Worker* represent *intrapersonal* skills that contribute to the effective performance of a team. Our construct *Interprofessional Collaboration*, however, comprises *interpersonal* skills and extends beyond teamwork to encompass an interdisciplinary environment that includes interacting with others, professionals and non-professionals alike, which facilitates positive organisational outcomes. The construct also indicates a service orientation that is central to this industry sector where complex technological innovation has to be demystified and sold to non-experts such as venture capitalists and other investors, lawyers, financial managers and end-users. Resolution of a construct emphasising interprofessional collaboration is most likely driven by the complex relationships and diversified nature of the organisations operating along the value chain of the industry sector where alliances, and licencing is paramount, and negotiation is a major business tool for royalties, annuities and returns. Together, the constructs represent two sides of the same coin.

Our results make the distinction between bringing knowledge to a team or firm (i.e., multidisciplinary) and learning in professional contexts that leads to interdisciplinarity. Interprofessionalism is defined as an approach to working in teams that emphasises highly collaborative problem solving where different professions learn with, from and about each other to improve outcomes (Barr, 1997; Bromage, 2009). Considered an important aspect of health care training since the 1950s, interprofessionalism has also been recognised as a phenomenon relevant to one of the most interdisciplinary of knowledge-intensive industries, biotechnology (MacKinnon *et al.*, 2010). In this high technology sector, where the product development pipeline can typically stretch to 15 years, innovation and commercialisation

requires contribution from a variety of professions including scientists, technical experts, engineers, intellectual property lawyers, business consultants, venture capitalists and entrepreneurial managers (Figure 1). In the medical and allied health professions, the term interprofessionalism encompasses both knowledge acquisition and leverage, and collaboration between professions to improve outcomes (e.g., Hammick *et al.*, 2007). In our study, however, skills relating to acquiring, applying and leveraging information and knowledge in this industry sector align within other constructs. Thus, the perceptions of the innovation and commercialisation industry support a divide in actual organisational practice between the role and application of knowledge and interprofessionalism (as adaptive behaviours) to achieve positive outcomes. In effect, the concepts of teamwork and interprofessionalism are more robust than is usually conceptualised in curriculum (Hammick *et al.*, 2007; Riebe *et al.*, 2010) as they are given meaning and purpose in action.

Leadership

Although leadership has only recently featured in skills frameworks, key leadership skills feature in our constructs: *Leadership Antecedence*, *Enterprise Leadership* and *Technical Management*. Such constructs are intuitive for an industry sector charged with bringing technological innovation through R&D and commercialisation to the marketplace. The importance of leadership also emerges from the second order EFA where four skills constructs coalesce to form the metaconstruct *Organisational Success* that represents leadership and experience as enablers of success of both the organisation and the individual. The elements in *Organisational Success* represent higher order applied skills in management, evaluation and progression of intellectual capital and organisations. The emphasis on leadership in our survey outcomes undoubtedly reflects both the demography of the industry respondents as senior level managers, who have already been selected based on their own leadership skills. Nonetheless, the emphasis on leadership skills in our results highlights a dimension of increasing importance in the current skills debate as organisations learn to harness the education and skills of employees to achieve their own organisational goals.

Graduate Skills Deficiencies Translate as Industry Requirements for Performance

Overall, our exploratory analysis suggests that the industry's perception of skills favours an outcomes focus driven by the commercial imperative rather than the process orientation often characteristic of curriculum. The outcomes focus is reinforced in second order EFA where the skills constructs derived from first order analysis coalesce in two metaconstructs

that centre on organisational purpose. The shift of understanding skills from a process (curriculum) perspective to an outcomes focus around organisational fit and success also suggests individual performance is a core theme in knowledge-intensive businesses operating in a globalised economy where capacity to drive innovation is the major competitive advantage. Indeed, performance emerges as an inherent theme in the skills classification derived in this study. While the academic discourse focuses on means, the industry focus is more economically pragmatic, placing emphasis on individual performance to address the commercial imperative (i.e., focused on ends). Hinchliffe and Jolly (2011) also report that employers perceive performance, interpreted as *delivery and results*, as a key component of graduate transition into the workforce. In this regard, (applied) performance in the workplace is distinct from academic capacity in HEI environments.

Implications

Our study provides insight into the value of skills and their application from the perspective of the firm. The broader stakeholder understanding of a shared language can assist graduate employability outcomes (Pellegrino and Hilton, 2012; Mourshed *et al.*, 2012). In contrast to the heterogeneous nature of most industry surveys, we sampled a homogeneous industry, the innovation and commercialisation sector, and as such the skills requirements and interpretations represent a narrow range of responses. However, the importance of fit, success and performance directly reflect those concerns witnessed in industry surveys regarding employability skills requirements (Harvey, 2003, 2005; Casner-Lotto and Barrington, 2006; Saflund, 2007; NACE, 2013) and where industry has voiced concerns in think tank reports (e.g., Hilton, 2008, 2010; Pellegrino and Hilton, 2012). Thus the imperatives of the innovation and commercialisation industry could be considered representative of knowledge-intensive industries in general (Pellegrino and Hilton, 2012; Mourshed *et al.*, 2012).

In the innovation and commercialisation sector, employers view graduate skills from the perspective of organisational fit. Fit in this context is dependent on the cognitive (knowledge) and personal skills that support the competitiveness and market advantage of the firm. In turn, organisational fit promotes the success of the individual and the firm. Thus, discourse around employability should shift from instilling (lists of) skills *per se* in students to enabling graduates to *perform*, competently and effectively, post-university to meet a diversity of workplace contexts and commercial expectations centred on organisational purpose.

In transition to careers, work integrated learning has assisted in promoting industry focused learning environments to students (Pegg *et al.*, 2012). However our findings suggest more needs to be done to narrow the skills gap and teach the employability skills to create the industry ready graduates demanded by knowledge-intensive industries. Skills such as leadership (Pegg *et al.*, 2012), interprofessional collaboration (Taajamaa *et al.*, 2014), systems thinking (Remington-Doucette *et al.*, 2012), information leverage (Wrigley and Bucolo, 2011) and service orientation (Swap and Wayland, 2013) are often learned from the view point of isolated subjects or co-curricular activities with such skills poorly integrated into the mainstream curriculum. For knowledge-intensive industries, however, we argue that all graduates also require an understanding of the commercial imperative.

How then can curriculum be redesigned to address the added skills perspectives pointed to by this study? Current programs cannot afford to sacrifice disciplinary knowledge, as core technical knowledge remains the paramount consideration of employers in such industries. The demand for technical knowledge is likely to increase as the merging of distinct disciplines – the convergence paradigm – continues to accelerate and fuel innovation and industrial evolution (MIT, 2011). Rather than fluency in one discipline, knowledge-intensive industries will be seeking technical knowledge in multiple disciplines to address complex-problem solving and decision-making processes. This sentiment has already been recorded in a survey of firms operating in the IT sector in the Boston region (Saflund, 2007). So ensuring technical knowledge (from multiple disciplines) is coupled with skills focused on the commercial imperative will inevitably “over-inflate” degrees increasing the timespan required to deliver such degrees (see Collet and Wyatt, 2005).

The motivation for this study was to analyse a cutting edge industry that operates in advance of most mainstream industries. There is not a template for managing in this industry. For the specifics of the innovation and commercialisation industry sector, our study also highlights a career and organisational progression from science (discovery) through technology (application) to management (implementation) that is rarely supported by an integrated education process. In the transition from discovery to implementation, management provides an extension to the science and technology underpinning the organisation rather than as an add-on activity (Liyanage and Poon, 2003; Phan *et al.*, 2009; Austin *et al.*, 2009). Frey and Osborne (2013) believe that the global shift to knowledge-intensive and technology-rich

industries will require employees who are both highly skilled technicians as well as creative business managers. Comprehensive, integrated curricula are required where targeted business concepts, processes and tools are embedded in technology-based disciplines to prepare students for commercial realities. Such curricula should be mainstream, rather than boutique offerings in HEIs (for examples see Collet and Wyatt, 2005; Barr *et al.*, 2009; Thursby *et al.*, 2009). Such skills imparted in graduates would be easily transferred into different workplace contexts and facilitate smoother transition into the workplace. This instillation is also a valid role for business schools to play in their universities.

Roos (2014) argues that business students need to learn about science and technology as this is where much of innovation occurs. Business education needs to bridge the divide between natural and social sciences. Similarly, faculties of science and technology need to search for and discover the value of the commercial imperative, to evolve towards a middle ground. If the curriculum redesign suggested does gain momentum, we will see integrative MBA programs cognisant of the underpinning science, technology and pathways to commercialisation increasingly take their place alongside current stand-alone MBA programs.

In summary, our demand side view of graduate skills provides a taxonomy of skills. However, lists remain just lists until the relationships between items are established (Pellegrino and Hilton, 2012). The connections between skills need to be drawn to understand the drivers that create the functional graduate as a whole. Our study has begun to tease out the connections between skills and explore the relationships between skills, organisational fit and performance, in terms of the individual and the firm in a competitive marketplace. Yet more progress towards closing the gap needs to be made. It is not that employers have failed to articulate their demands clearly to the higher education sector (Rosenberg *et al.*, 2012) as employers have responded *ad infinitum* to surveys dominated by simple lists (Lai and Viering, 2012). The failure to generate the second and third generation skills frameworks that are empirically meaningful, widely accepted and validated in industry settings presents a missed opportunity to date for the graduates of higher education. Good policy relies on robust, evidentially supported guidance to coordinate and assist all stakeholders – students, industry and HEIs – simultaneously.

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[Legend to Table 1 (next page)]

Table 1: Generic skills frameworks mapped to the taxonomy of Pellegrino and Hilton (2012).
The OECD (2005), UKCES (2009), P21CS (2009) and AT21CS (Binkley *et al.*, 2010) frameworks are mapped to the three clusters of key competencies defined by Pellegrino and Hilton (2012) as: cognitive, interpersonal and intrapersonal.

	Skills Frameworks				
	OECD Key Competencies OECD (2005)	UKCES Employability Skills UKCES (2009)	21 st Century Skills AT21CS (Binkley <i>et al.</i> , 2010)	Partnership for 21 st Century Skills Adapted from P21CS (2009)	Transferable 21 st Century Skills (Pellegrino & Hilton, 2012)
COGNITIVE COMPETENCY CLUSTER	Use tools interactively <ul style="list-style-type: none"> Use language, symbols and text interactively Use knowledge and information interactively Use technology interactively 	Thinking and solving problems <ul style="list-style-type: none"> Creativity, reflecting on & learning from own actions, prioritising, analysing situations,, developing solutions Using numbers effectively <ul style="list-style-type: none"> Measuring, recording measurements, calculating, estimating quantities, relating numbers to the job Using language effectively <ul style="list-style-type: none"> Writing clearly & in a way appropriate to the context, ordering facts and concepts logically Using IT effectively <ul style="list-style-type: none"> Operating a computer using basic systems and learning other applications as necessary, using telephones and other technology to communicate Understanding the business <ul style="list-style-type: none"> Understanding how the individual job fits into the organisation as a whole, Recognising the needs of stakeholders, judging risks, innovating, contributing to the whole organisation 	Ways of thinking <ul style="list-style-type: none"> Creativity and innovation Critical thinking, problem solving, decision making Learning to learn, metacognition Tools for working <ul style="list-style-type: none"> Information literacy ICT literacy 	Core subjects & 21st Century themes <ul style="list-style-type: none"> Core subjects: English, world languages, arts, mathematics, economics, science, geography, history, government & civics 21st Century themes: literacies in global awareness, finance, economics, business and entrepreneurship, civics, health, environment Information, media & technology <ul style="list-style-type: none"> Information literacy <ul style="list-style-type: none"> Access & evaluate information Use and manage information Media literacy: analyse & create media ICT literacy: apply technology effectively Learning & innovation skills (1) <ul style="list-style-type: none"> Creativity and innovation <ul style="list-style-type: none"> Think creatively Work creatively with others Implement innovations Critical thinking & problem solving <ul style="list-style-type: none"> Reason effectively Use systems thinking Make judgements & decisions Solve problems 	Cognitive <ul style="list-style-type: none"> Cognitive processes & strategies <ul style="list-style-type: none"> Critical thinking Problem solving Analysis, interpretation Reason, argumentation Decision making Adaptive learning Executive function Knowledge <ul style="list-style-type: none"> Information literacy ICT literacy Communication – oral, aural, written Creativity <ul style="list-style-type: none"> Creativity Innovation
INTERPERSONAL COMPETENCY CLUSTER	Interact in heterogeneous groups <ul style="list-style-type: none"> Relate well to others Cooperate, work in teams Manage and resolve conflicts 	Working together and communicating <ul style="list-style-type: none"> Cooperating, being assertive, persuading, being responsible to others, speaking clearly to individuals & groups & listening for a response 	Ways of working <ul style="list-style-type: none"> Communication Collaboration (teamwork) 	Learning & innovation skills (2) <ul style="list-style-type: none"> Communication & Collaboration <ul style="list-style-type: none"> Communicate clearly Collaborate with others Life & Career Skills (1) <ul style="list-style-type: none"> Social & cross cultural skills <ul style="list-style-type: none"> Interact effectively with others Work effectively in diverse teams Leadership & responsibility <ul style="list-style-type: none"> Guide & lead others Be responsible to others 	Interpersonal <ul style="list-style-type: none"> Teamwork & collaboration <ul style="list-style-type: none"> Communication Collaboration Teamwork Cooperation, coordination Interpersonal skills Empathy/perspective Trust Service orientation Conflict resolution Negotiation Leadership <ul style="list-style-type: none"> Leadership Responsibility Assertive communication Self-presentation Social influence with others
INTRAPERSONAL COMPETENCY CLUSTER	Act autonomously <ul style="list-style-type: none"> Act within the big picture Form and conduct life plans and personal projects Defend and assert rights, interests, limits and needs 	Positive Approach <ul style="list-style-type: none"> Ready to participate make suggestions, accept new ideas & constructive criticism, take responsibility for outcomes Self Management <ul style="list-style-type: none"> Punctuality & time management, fitting dress & behaviour to context, overcoming challenges and asking for help when necessary 	Living in the world <ul style="list-style-type: none"> Citizenship – local and global Life and career Personal and social responsibility – including cultural awareness and competence 	Life & Career Skills (2) <ul style="list-style-type: none"> Initiative & self-direction <ul style="list-style-type: none"> Manage goals & time Work independently Be self-directed learners Productivity & accountability <ul style="list-style-type: none"> Manage projects Produce results Flexibility & adaptability <ul style="list-style-type: none"> Adapt to change Be flexible 	Intrapersonal <ul style="list-style-type: none"> Intellectual openness <ul style="list-style-type: none"> Flexibility, adaptability Artistic and cultural appreciation Personal and social responsibility Appreciation for diversity Continuous learning Intellectual interest and curiosity Work ethic/Conscientiousness <ul style="list-style-type: none"> Initiative, self-direction Responsibility, perseverance, productivity Self regulation: forethought, performance, self-reflection Professionalism, ethics Integrity Citizenship Career orientation Positive core self evaluation <ul style="list-style-type: none"> Self: monitoring, evaluation, reinforcement Physical and psychological health

Table 2: Numbers of organisations surveyed in the different categories representing the Australian innovation and commercialisation industry infrastructure (see also Figure 1).

Type of Organisation	Number surveyed
Venture Capital	44
R&D Consortium	28
R&D Funding Agency	11
Commercialisation/Translational Organisation	15
Management and Financial Consulting	17
Government Agency	7
Commercial Law	9
Research Facility	8
Research Centre	25
Research Institute	22
Research Organisation	21
TOTAL	207

[Legend for Table 3 (next page)]

Table 3: The ten skills fields constructs (column 1) resolved by first order principal component analysis with Promax rotation and Kaiser normalisation. Each construct shows high Cronbach α (CA) values (column 2) and Eigenvalues > 1 (column 2) that together explain 66% of the cumulative total variance (column 3). Column 4 describes the alignment of individual skills with higher order skills fields constructs while columns 5 and 6 provide the means of IMP response (I_m) and difference between the means of IMP and EVD ($I_m - I_E$) for each skill item, respectively. For all 61 items, one-tailed t-tests with Bonferroni correction showed IMP_{Mean} to be significantly higher than EVD_{Mean} ($p/2 < 0.001$) (data not shown). The size effect was determined using Cohen's d test and 59 items showed d values (column 7) > 0.5 (medium to large), with two items returning d values of 0.320 and 0.456 indicating a small to medium size effect.

Skill Field Construct	Eigen-value / CA	% of Var	Items	I _M	I _M -E _M	d value	Factor Load'
#1 <i>Knowledge</i>	20.800 / 0.905	34.098	Evaluate information and data	4.61	1.07	1.302	0.849
			Accurately report information	4.55	1.03	1.290	0.846
			Synthesise information and data	4.51	1.13	1.327	0.845
			Accurately document information from different sources	4.44	0.95	1.142	0.816
			Critically question	4.47	1.13	1.187	0.704
			Communicate effectively with discipline specialists	4.32	1.03	1.186	0.662
			Understand essential concepts relating to the specific discipline	4.41	0.77	0.928	0.622
			Share new knowledge with others	4.19	0.79	0.995	0.594
			Basic general knowledge in technical area	4.11	0.75	0.892	0.532
			Retrieve information from different sources	4.48	0.66	0.880	0.531
#2 <i>Enterprise Leadership</i>	5.327/ 0.911	8.732	Lead a new venture	3.22	0.81	0.760	0.784
			Marshal resources for a new enterprise	3.36	0.95	0.887	0.783
			Identify key people in a venture	3.64	1.08	1.035	0.773
			Gain management support for a new enterprise	3.40	0.80	0.728	0.708
			Inspire others	3.71	0.84	0.900	0.703
			Negotiate	3.73	1.20	1.220	0.680
			Knowledge of administrative systems	3.03	0.90	1.237	0.670
			Form an effective team	3.80	1.05	1.000	0.658
			Willingness to take risks	3.30	0.60	0.624	0.657
			Work effectively in uncertain environments	3.97	1.04	1.112	0.645
			Influence team behaviour to promote positive team outcomes	3.98	0.98	1.077	0.610
			Plan business ventures	2.97	0.83	0.756	0.599
			Recognise an opportunity	3.95	1.37	1.500	0.570
			Work autonomously	3.98	0.71	0.762	0.523
			Adapt to new situations	4.17	0.88	1.039	0.458
#3 <i>Business Function</i>	2.067/ 0.839	3.389	Knowledge of accounting	2.61	0.52	0.456	0.835
			Knowledge of financial systems	3.08	0.81	0.710	0.804
			Knowledge of general principles of law relating to business	2.86	0.80	0.664	0.781
			Knowledge of marketing	2.82	0.70	0.690	0.732
#4 <i>Technical Management</i>	1.967/ 0.880	3.225	Manage a project	3.98	1.13	1.155	0.760
			Mentor	3.45	0.86	0.829	0.704
			Reach a timely independent decision	3.86	0.95	1.025	0.695
			Apply knowledge in practice	4.35	1.10	1.370	0.693
			Build positive customer relations	3.98	0.90	0.813	0.672
			Apply discipline knowledge to solution of problems of an unfamiliar nature	4.02	1.22	1.338	0.668
			Apply discipline knowledge to solution of problems of a familiar nature	4.17	0.68	0.757	0.661
#5 <i>Team Worker</i>	1.792/ 0.794	2.937	Deep knowledge of a specific discipline	3.83	0.59	0.566	0.657
			Behave in a non-judgmental manner	3.99	0.69	0.743	0.763
			Respond positively to feedback	4.22	0.77	0.935	0.682
			Appreciation of cultural diversity	3.86	0.31	0.320	0.658
			Reflect on own performance	4.20	1.01	1.167	0.623
			Interpret team dynamics	3.84	1.01	1.061	0.589
#6 <i>Interprofessional Collaboration</i>	1.594/ 0.845	2.613	Awareness of roles and responsibilities of team members	4.00	0.85	0.919	0.553
			Adapt one's own skills and knowledge to fit with other professionals	4.09	0.90	1.061	0.807
			Work collaboratively with other professions	4.36	1.00	1.158	0.766
			Work in an interdisciplinary team	4.25	0.83	0.935	0.698
			Communicate effectively with non-experts	4.16	1.17	1.299	0.693
#7 <i>Leadership Antecedence</i>	1.429/ 0.713	2.343	Appreciation of the client's perspective	4.29	1.14	1.165	0.670
			Effective written communication skills	4.52	1.34	1.660	0.710
			Effective oral communication skills	4.45	1.01	1.294	0.694
			Strong action orientation	4.12	0.87	1.070	0.609
#8 <i>Progress</i>	1.358/ 0.839	2.227	Drive to succeed	4.40	0.65	0.875	0.556
			Knowledge of commercialisation pathways	3.25	1.12	1.021	0.788
			Understanding of technology valuation	3.06	0.84	0.709	0.766
			Understand emerging technology and its potential impact	3.66	0.77	0.743	0.715
#9 <i>Improve</i>	1.235/ 0.828	2.024	Understanding of new product/service development processes	2.99	0.87	0.801	0.708
			Responsibility for continuing professional learning	4.07	0.52	0.580	0.833
#10 <i>Create</i>	1.195/ 0.794	1.958	Initiative for continuing professional learning	4.01	0.62	0.680	0.810
			Acquire new external knowledge	4.32	0.71	0.914	0.716
			Assimilate new external knowledge with existing knowledge	4.36	0.83	1.089	0.610
Cumulative % of Variance:		63.5	Create new knowledge	4.00	0.80	0.782	0.564

Table 4: Second order EFA resolved two metaconstructs that suggest organisational fit and organisational success underpin the industry response to skills requirements. Column 2 provides the derived Eigenvalues and Cronbach α (CA) values.

Metaconstruct	Eigenvalue / CA	% of Variance	Skills Fields	Factor Loading
#1 Organisational Fit	5.558/ 0.635	55.583	<i>Knowledge</i> <i>Interprofessionalism</i> <i>Create</i> <i>Team Worker</i> <i>Leadership Antecedence</i> <i>Improve</i>	0.872 0.792 0.789 0.745 0.734 0.705
#2 Organisational Success	1.272/ 0.678	12.716	<i>Enterprise Leadership</i> <i>Progress</i> <i>Business Function</i> <i>Technical Management</i>	0.895 0.849 0.822 0.816
Cumulative % of Variance		68.299		

Figure 1: Conceptual framework of the innovation and commercialisation industry displaying the types of organisations and their relationship to the pipeline process. Abbreviations used: R&D = research and development, R&d = research and initial development.

